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(54) Resilient engine mounting

(57) A resilient engine mounting for a vehicle has metal components 1, 2 interconnected by at least one deformable component 3a formed of highly elastic elastomeric material to isolate the vibrations of one of the metal components from the other metal component(s) and at least one further deformable component 4a of a rubber-like composition having a high damping property for suppressing lower frequency vibrations, for example those arising due to road shocks experienced by the vehicle in motion.

Fig. 1 Fig. 2

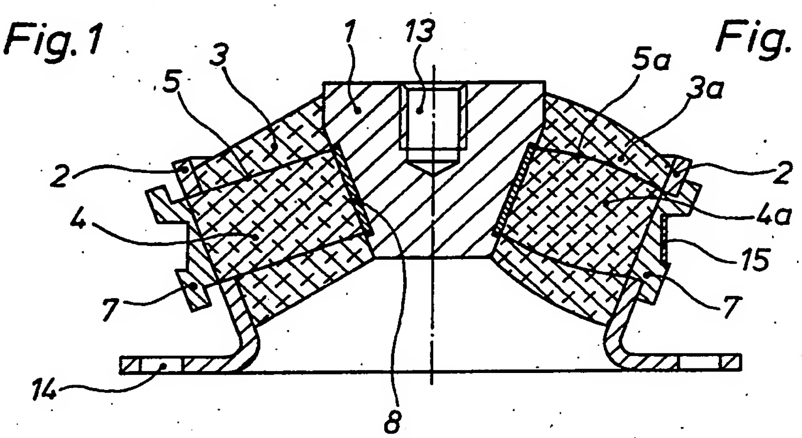

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Fig. 1

Fig. 2

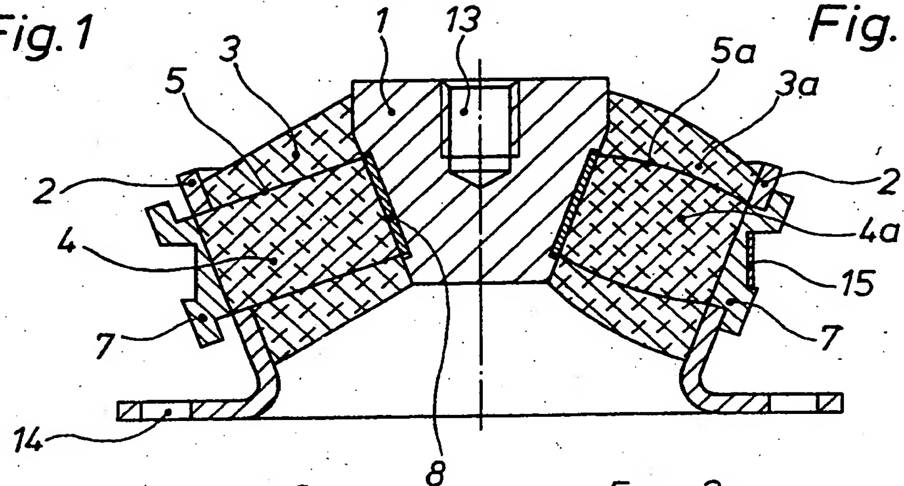


Fig. 3

Fig. 4

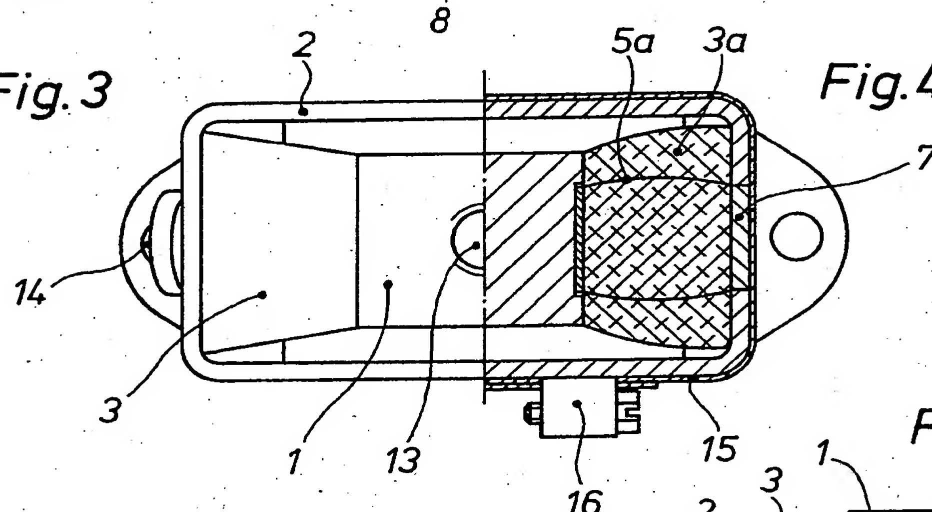


Fig. 5

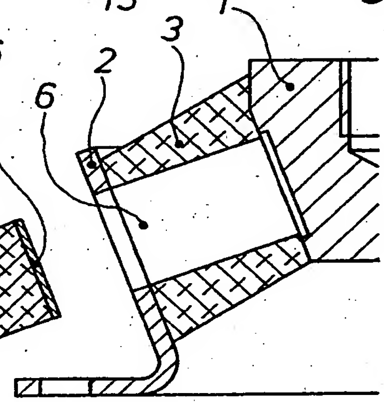


Fig. 6

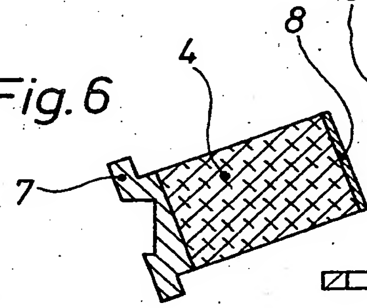


Fig. 7

Fig. 8

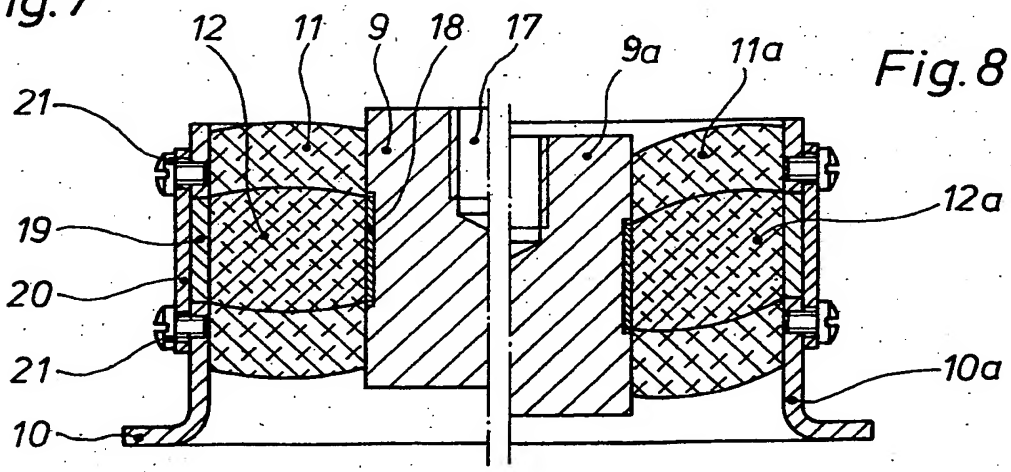


Fig. 9

Fig. 11

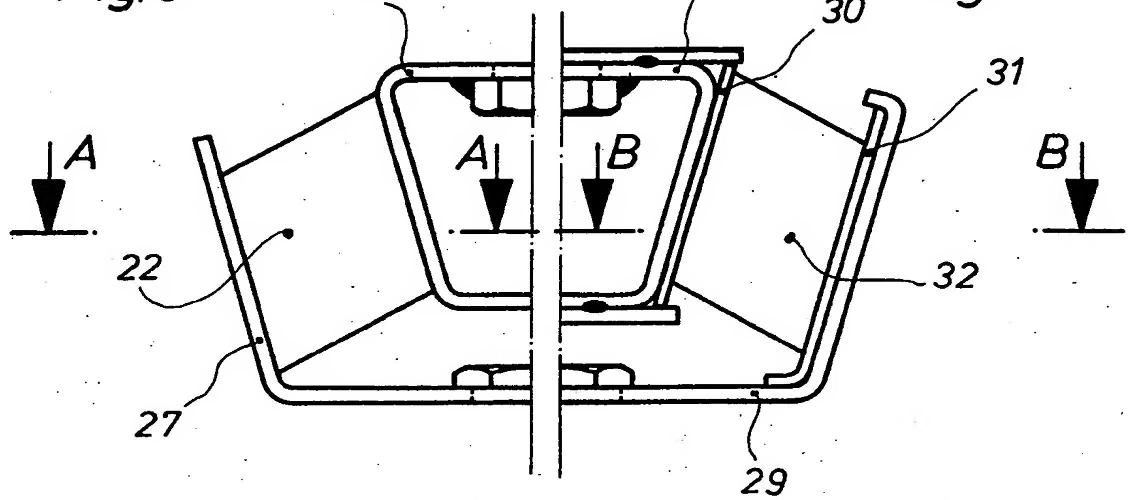
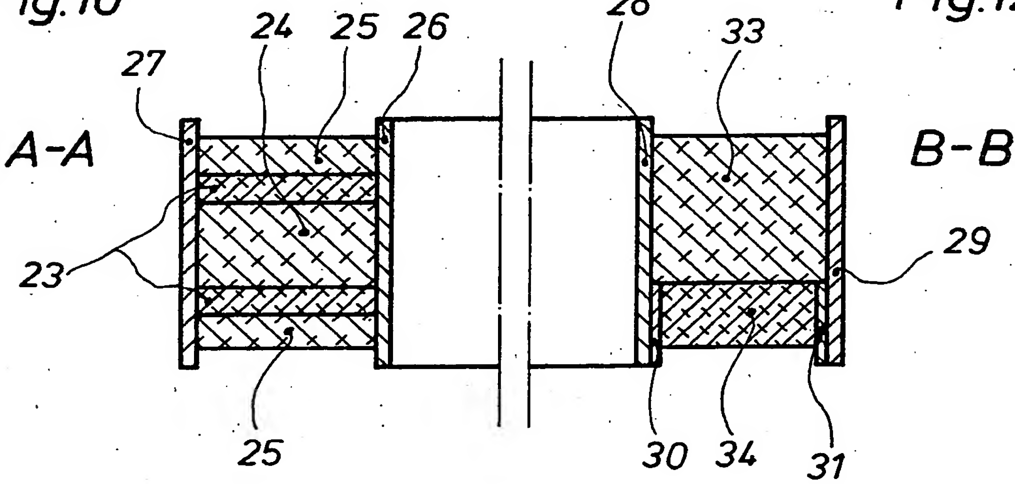


Fig. 10

Fig. 12



SPECIFICATION

Resilient engine mounting

The present invention relates to a resilient engine mounting. In particular such a mounting may be used for motor vehicles, and is one in which two or more metal components which can move in relation to each other are interconnected by way of one or several rubber components subjected to shear and/or compressive stress.

It is usual to mount the driving engine of road and track vehicles as well as of ships elastically on rubber-metal elements. The elastic properties of the elastic elements are designed to suit the generated shear and torsional oscillations according to vibration theory in such a way that these elements largely prevent a transmission of the oscillations generated by the engine to the body of the vehicle. For this purpose particularly soft elastic properties are required which produce a low natural vibration frequency, as far as possible below the frequencies of excitation.

In the case of such vibration-insulating rubber metal engine mountings, which connect the engine with the body of the vehicle, the rubber is subjected to shear stress or both shear and compressive stress by the vibration forces of the engine. The rubber mixtures used must be highly elastic because it is only such highly elastic mixtures which will be free from any substantial plastic deformations under the static and dynamic forces or alterations of the engine characteristics with higher load frequencies. However, these mixtures only have low damping properties.

The required high elasticity of the usual type of engine mounting has the disadvantage that, due to the springiness of the mounting, a vibration of the engine mass generated by individual extraneous shocks lasts for a fairly long time and only fades slowly. This occurs for instance with travel shocks due to road potholes, or unevenness of the road surfaces at short intervals (the so-called washboard effect), and is particularly unpleasant when the elastic property is very soft allowing the natural vibration of the engine caused by travel shocks to have a high amplitude. The natural vibration of the relatively large engine mass causes the whole motor vehicle to vibrate. It is therefore desirable to add to the vibration insulating elastic mounting a damping element which damps such extraneous natural vibrations i.e. causes them to fade rapidly.

Attempts have been made to use highly damping rubber or synthetic rubber mixtures for the rubber-metal mounting elements. Since however these are not sufficiently elastic they do not produce any vibration insulation. Moreover, the creep and set values are too high and thus the mounting elements made of highly damping mixtures are subject to plastic deformation under the static and dynamic forces occurring under the operating conditions.

In the case of motor vehicles with a higher degree of road comfort, vibration absorbers (e.g. hydraulic dampers) are arranged below the engine in a parallel arrangement to the rubber-metal element. This solution of the problem is admittedly effective but expensive. It requires considerable space for the installation. Hydraulic dampers can also be integrated directly into the rubber-metal element which then becomes correspondingly bulky and expensive. Moreover, (a) the hydraulic damper is subject to wear and tear and gradually becomes less effective, (b) it only damps vibrations which occur along the direction of its axis and (c) it forms an undesirable sound bridge.

The object of the present invention is to create an elastic engine mounting with damping which requires little effort and expenditure, is economical in terms of space, is durable and is completely free of maintenance requirements and does not transmit any noise.

Accordingly the present invention provides a resilient engine mounting in which two or more metal components are movably mounted with respect to each other and are interconnected by:— at least one deformable component of highly elastic rubber with poor damping properties and at least one further resilient component of a rubber-like material with high damping qualities extending between and bonded to said two or more metal components, the first mentioned and further deformable components being in contact with one another. Thus there is added to the vibration-insulating elastic element, formed by a highly elastic rubber component, a damping element which consists of a damping component made of a rubber-like material. The damping component may be wholly or partly enclosed by the elastic component and is constrained to follow the movements of the latter. In this way it damps the vibrations in the elastic component of the engine mounting and surprisingly does this substantially more effectively than would be expected from the damping proportions based on the volmetric ratio of the damping material in relation to the elastic material. Due to the forced deformation of the damping material, which material has a higher loss factor (tan ϵ) than the elastic material of the spring element and therefore shows a phase shift in relation to the deformation of the elastic material, there occurs a retardation of the vibration motion which additionally enhances damping of the whole element. In addition, the vibration isolating effect of such an elastic element is significantly better in comparison with a combination of a spring and liquid absorber because of the special damping behaviour of highly damping rubber or synthetic rubber mixtures. The damping effect of highly damping rubber and synthetic rubber mixture depends on the rate of deformation. For a given frequency it is therefore substantially more effective with high amplitudes than with low ones. In crossing road surfaces exhibiting the so-called "washing-board" effect, or similar extraneous vibration generators, there will be a damping which as is desirable in this context is substantially higher than with the low amplitudes of the hypercritical vibrations generated by the engine where damping is undesirable. The damping effect can be enhanced further in that the damping component is made of a mixture with a higher shear modulus. It is also effective in the case of forces or shocks acting laterally.

The said further deformable component consisting of a rubber-like material with high damping qualities may have, before assembly, the shape of a cylinder or prism which has on its ends metal components attached by vulcanisation and is subsequently pressed into a cutout of the pre-vulcanised mounting element which penetrates the rubber component and the outer metal component and extends into the inner metal component to be fixed therein. Since it is often difficult to vulcanise the said further deformable component made out of a material with high damping properties, to the elastic rubber of the first mentioned deformable component in one process, the said further deformable component is produced in a separate process of vulcanisation and may, since it has the shape of a cylinder or prism, be easily introduced into the corresponding bore of the finished, vulcanised first mentioned mounting element. A slight taper of the side walls of the damping component facilitates insertion. It is particularly important with this arrangement, that the said further deformable component should, whilst having the same cross-section as the accommodating bore, be longer than the accommodating bore before being pressed in, that is to say its volume should be larger than that of the accommodating bore. With this design, the said further deformable component is compressed during insertion and bulges laterally outwards since the material has a constant volume. As early as after a few days, the damping component will have adopted the bulging shape without stress because of the pronounced relaxation of the mixtures used. The surrounding highly elastic rubber of the first mentioned deformable component is displaced and exerts, by way of reaction, compressive stresses on the damping component from all sides so that an adequate frictional connection is achieved between the two elastomers. The said further deformable component is therefore constrained, upon movement of the whole engine mounting, to join in the deformation at every point without the possibility of sliding or rubbing between the two elastomers. This is important in order to minimise or avoid abrasion and destructions at the interfaces of the elastomers.

The said at least one further deformable components may sub-divide the said first mentioned deformable component into two or several layers. This provides a further possibility for the insertion of the said further deformable component. The latter is inserted from the side of the free rubber faces and may be fixed by means of attached metal components.

Finally the or each said further deformable component may be attached asymmetrically with respect to the central longitudinal plane, or even outside the said first mentioned deformable component. With this construction it is very simple to insert the damping component subsequently, since it may for instance be attached laterally. This design is particularly favourable for experimental mounting where substitution by a different said further deformable component may be desired. Here the interfaces between the elastic and damping component may be connected by means of a rubber solution or adhesive.

This invention thus creates an elastic mounting with parallel damping which requires little effort and expenditure, is economic in space requirements, durable, and is entirely free of maintenance and wear and tear. The damping depends on the rate of deformation of the highly damping rubber-like material so that with high amplitudes there will be a greater damping effect than with low amplitudes. Finally it is particularly advantageous that the damping occurs irrespective of the direction of impact and that it does not favour any noise transmission (this being inevitably the case with liquid vibration absorbers).

In order that the present invention may more readily be understood the following description is given, merely by way of example with reference to the accompanying drawings, in which:—

FIGURE 1 shows a vertical longitudinal section through one half of an engine mounting with an embedded damping element which is subjected to shear stress and compressive stress;

FIGURE 2 is a vertical longitudinal section through the other half of the same engine mounting but with an embedded prestressed, i.e. compressed and fixed, damping element;

FIGURE 3 is a plan view for the configuration shown in Figure 1;

FIGURE 4 is a plane view, partly in cross-section for the configuration of Figure 3;

FIGURE 5 is a vertical longitudinal section through half of an engine mounting in a finished vulcanised but unassembled state;

FIGURE 6 shows the damping element for the engine mounting according to Figure 5 in a finished vulcanised state;

FIGURE 7 shows a vertical longitudinal cross-section through an engine mounting with a prestressed embedded damping element, to be subjected to shear stress in operation;

FIGURE 8 is a vertical longitudinal cross-section through the other half of the engine mounting of Figure 7, when in a deformed state;

FIGURE 9 is a side view of one half of a symmetrically constructed engine mounting, open at the side, to be subjected to shear stress and compressive stress in operation;

FIGURE 10 is a horizontal section taken on line A-A of Figure 9;

FIGURE 11 is also a side view, of one half of an engine mounting subjected to shear and compressive stress, including a further design of the damping component, non-embedded; and

FIGURE 12 is a horizontal section taken on the line B-B of Figure 11.

In Figures 1 and 3 the inner wedge shaped metal component 1 and the outer trough shaped metal component 2 of an engine mounting are connected *via* two rubber components 3 which are attached by vulcanisation on both sides and made of highly elastic rubber. These components 3 serve to isolate vibrations of one of the metal components, for example component 1, from the other component. The inner metal component 1 is provided with a threaded bore 13 for the bolt for fixing the engine bearer to the component 1. Bore 14 in the outer metal component

2 is used for fixing the component 2 to the chassis. A cylindrical plug 4, inserted into cutouts of the rubber component 3 and of the metal component 2 from the outside consists of a highly damping rubber component and has the faces of metal plates 7 and 8 attached to the plug 4 by vulcanisation. This plug component damps the vibrations of one of the metal components relative to the other component and is more effective in its damping action when the incident vibrations are low frequency high amplitude vibrations as compared with the vibrations normally arising due to engine operation. The side walls 5 of the plug 4 form a cylinder or prism. The side walls 5 can also have a frusto-conical shape with a shallow taper angle. Metal plate 8 is engaged in a corresponding recess of the wedge shape metal component 1. Although plug 4 fits in the hole cut out in rubber component 3, it projects towards the outside.

In Figures 2 and 4, a steel band 15 is shown laid round the outer metal component 2 of the same engine mounting and over the metal plate 7 of the damping plug 4. Tightening the steel band 15, by means of tightener 16 (Figure 4), presses the damping plug 4 into the cutout to cause the side walls *5a* of damping rubber component *4a* to bulge outwards and in turn to bulge the outer elastic rubber component *3a*. Whereas the internal stresses generated by the forced insertion of the damping rubber plug *4a* rapidly fade, the stresses which occur in the highly elastic rubber component *3a* as a result of the deformation remain causing it to press inwardly against, and hence to squeeze, the damping rubber plug *4a*. Thus a frictional connection is obtained between the rubber bodies *3a* and *4a* which facilitates a good shear stress transmission from the elastic rubber component 3 or *3a* onto the damping plug 4 or *4a* upon loading of the whole engine mounting and the ensuing shear deformations of the rubber.

Figure 5 shows once more the half of the mounting which is shown in Figure 1, but now after vulcanisation and before insertion of the damping component. It shows recess 6 which is to be used to accommodate the embedded damping rubber component.

Figure 6 shows the damping component about to be introduced into cut out 6 of the main rubber component 3. This plug 4 of the highly damping rubber component already having the metal plates 7 and 8 attached thereto by vulcanisation, is longer than the depth of cutout 6 shown in Figure 5. The volume of the damping rubber component forming plug 4 amounts to approximately 15 to 30% of the total rubber volume.

Upon loading, the symmetrically constructed engine mounting shown in Figure 7, has its rubber components 11, 12 only subjected to shear stress. The inner metal component 9 with threaded bore hole 17 for the engine bearer mounting bolt is connected to the outer component 10 *via* the elastic rubber component 11 and the damping rubber component 12. The damping rubber component is again a plug provided with metal plates 18 and 19 attached by vulcanisation and is retained prestressed in a compressed condition by a metal plate 20 and screws 21.

Figure 8 shows the other half of the engine mounting of Figure 7 with the inner metal component *9a* and the elastic rubber component *11a* under vertical loading imposed by the engine and with the shear deformation deriving therefrom. The elastic rubber component *11a* and the damping rubber component *12a* are subjected to shear deformation of equal strain values.

In Figures 9 and 10, between an inner wedge-shaped metal component 26 and an outer stirrup shaped metal component 27 there is vulcanised a deformable component 22 which is formed by three spaced layers 24, 25 made of elastic rubber and two intermediate layers 23 made of a rubber-like damping substance e.g. synthetic rubber. The layers 23, 24, and 25 have been combined into a single body even before vulcanisation. For this purpose an adhesive may be used at the interfaces.

In Figures 11 and 12, an elastic rubber component 33 has been fitted by vulcanisation between the inner metal component 28 and the outer metal component 29. The damping component 24, with the metal plates 30 and 31 attached to it, is fixed on the inner metal component 28 and on the outer metal component 29 of the engine mounting. The fixing of the plates 28, 29 to the rest of the engine mounting is illustrated in Figure 11.

Although, in the above description I have referred to "rubber-like" for the composition used in the damping component, any suitable plastics material will suffice if it has the desired high degree of damping. Equally any elastomer will suffice in place of rubber for the "high elasticity" component, e.g. 3.

CLAIMS

1. A resilient engine mounting in which two or more metal components are movably mounted with respect to each other and are interconnected by:— at least one deformable component of highly elastic rubber with poor damping properties and at least one further resilient component of a rubber-like material with high damping qualities extending between and bonded to said two or more metal components, the first mentioned and further deformable components being in contact with one another.

2. A resilient engine mounting according to claim 1, wherein said at least one further deformable component is substantially in the shape of a cylinder or prism before insertion into the mounting; wherein it is provided at its ends with metal components attached by vulcanisation; and wherein it is subsequently pressed into a cutout of the pre-vulcanised mounting to penetrate the said first mentioned deformable component and the outer metal component and continue into the inner metal component to be fixed therein.

3. A resilient engine mounting according to claim 2, wherein the said at least one further deformable component has the same cross-section as the cutout intended to accommodate it, and either is longer than the cutout before insertion or has before insertion a volume greater than that of the cutout.

4. A resilient engine mounting according to claim 2 or 3, wherein said at least one further deformable component has its side walls shallowly tapered to facilitate insertion into the cutout of said first-

mentioned deformable component.

5. A resilient engine mounting according to any one of claims 2 to 4, wherein one of said movable metal components is placed centrally of the other movable metal component with one said first mentioned deformable component and one said further deformable component separating said first metal component from said other metal component at each of two opposite sides thereof; and wherein the two said further deformable components are maintained under compressive strain within the said cutouts by virtue of a strap passing around the said second metal component and engaging one of the said metal components vulcanised to each respective said further deformable component.

6. A resilient engine mounting according to claim 1, wherein several said further deformable components separate two or more layers forming the said first mentioned deformable components.

7. A resilient engine mounting according to claim 1, wherein said further deformable component is affixed to the said first mentioned deformable component asymmetrically with respect to the central longitudinal plane, or on the outside of the said first mentioned deformable component.

8. A resilient engine mounting according to any one of the preceding claims, wherein said first mentioned and further deformable components are prestressed in both compression and shear.

9. A resilient engine mounting according to any one of the preceding claims, wherein the configuration of said metal components and said first mentioned and further deformable components is such that, in use, the said first mentioned and further deformable components will be subjected to shear stress.

10. A resilient engine mounting according to any one of claims 1 to 8, wherein said metal components and said first mentioned and further deformable components are arranged such that said first mentioned and further deformable components will, in use, be subjected to both compressive and shear strain.

11. A resilient engine mounting substantially as hereinbefore described with reference to, and as illustrated in, Figures 1 to 5 of the accompanying drawings, Figures 7 and 8 of the accompanying drawings, Figures 9 and 10 of the accompanying drawings, or Figures 11 and 12 of the accompanying drawings.

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